Operating Experience Weekly Summary 97-36

August 29 through September 4, 1997

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EVENTS

1. SMALL FIRE IN AN OVEN AT LOS ALAMOS NATIONAL LABORATORY

On August 25, 1997, at the Los Alamos National Laboratory Chemistry and Metallurgy Research Facility, a small fire occurred in an electric oven located in a radiologically controlled area. On August 21, a Health Physics Operations staff assistant and a Health Physics Measurements technician used the oven to dry and ash a cotton mop-head. They wanted to determine whether the mop contained low-level radioactivity because it could have been the source of contamination for several recent facility occurrences involving low levels of plutonium-238. At the end of the day, the technician reduced the oven temperature and left it operating unattended over the weekend. When the technician entered the room on August 25, he saw light smoke coming from the oven vent and sides. He turned the oven off and notified his supervisor. The supervisor and an operator entered the room to assist the technician. They unplugged the oven and activated a fire alarm. Firefighters responded and determined that no fire-fighting action was necessary. The fire did not involve radioactive material, and there was no spread of contamination. Nasal smears from the technician, supervisor, and operator were negative. Unattended weekend operation of ovens, furnaces, and hot-plates should be avoided unless they are fail-safe and knowledgeable personnel are available for emergency response. Oven fires can result in equipment and facility damage and personnel injuries. (ORPS Report ALO-LA-LANL-CMR-1997-0016)

The facility manager convened a critique and suspended drying/ashing operations pending a review of the circumstances surrounding the incident. Critique members determined that Health Physics Operations personnel routinely used the oven to dry and burn (ash) samples to determine if they contain low-level alpha activity below detectable thresholds for portable alpha survey instruments. However, they did not place samples in the oven if sample surveys detected any activity. No activity had ever been detected on the outside surfaces of the oven or on the oven's vent port, which vented into the room. However, personnel had observed very light whiffs of smoke coming out of the oven vent port during previous ashing operations.

Critique members also determined that on August 22, the staff assistant surveyed the damp mop-head, detected no activity, then placed it in the oven at 250 degrees Fahrenheit to slowly dry it. Subsequent surveys detected no activity, so he cut the mop-head into several pieces to accelerate the drying process. Because additional surveys detected no activity, the staff assistant, a team leader, and a technician discussed further actions. They determined the best course was to dry and ash the mop-head and then analyze the ash residue with extremely sensitive measurement techniques. They discussed a procedure for drying and ashing the mop-head, after which, the technician began the drying procedure. After the oven operated at 250 degrees Fahrenheit for the rest of the day, the technician turned the temperature control down to 200 degrees and left the mop-head to dry over the weekend. Critique members determined that the technician returned to the room on August 25 and the oven was still operating at 200 degrees Fahrenheit. Critique members learned that when fire protection personnel opened the oven door on August 27, they found the charred remains of the mop-head and charring on the inner walls of the oven and the door gasket. During the critique, attendees also learned that there was no written procedure covering the drying/ashing process. The facility manager initiated a review of all health physics analysis laboratory processes in the Chemistry and Metallurgy Research Facility to determine whether they all had written procedures. The facility manager also contacted the facility manager at the Plutonium Processing and Handling Facility because they may perform similar processes.

OEAF engineers also reviewed an occurrence report this week regarding the suspension of normal operations at the Chemistry and Metallurgy Research Facility. On September 2, 1997, the division director for Chemical Science and Technology suspended operations because of events that occurred over the past several weeks. These events involved violating procedures, performing unauthorized work, and failing to invoke stop work orders. The suspension will be in effect until work control and work authorization processes are fully verified. (ORPS Report ALO-LA-LANL-CMR-1997-0016)

NFS reported fires, explosions, and toxic substance releases during operation of ovens, furnaces, and hot-plates in several Weekly Summaries.

- Weekly Summary 96-44 reported that an unattended electric bake-off oven in a laboratory at the Savannah River Site caught fire when it overheated because a temperature controller failed. The oven was used for heating, drying, and evacuating materials. A laboratory technician did not follow procedures that required notifying control room personnel of the unattended experiment and providing instructions for emergency shut-down of the oven. (ORPS Report SR--WSRC-LTA-1996-0036)

- Weekly Summary 96-22 reported that a silica tube containing a mixture of niobium and red phosphorus exploded in an electric tube furnace at the Ames Laboratory. The researcher in charge had left the room before the explosion. (ORPS Report CH--AMES-AMES-1996-0002)

- Weekly Summary 96-10 reported that an unattended beaker of hydrochloric acid was drying on a hot-plate at the Los Alamos National Laboratory Radiochemistry Site when acid vapors exceeded the 5-ppm threshold limit value ceiling. A radiological control technician and a researcher were exposed to the airborne hydrochloric acid vapors. (ORPS Report ALO-LA-LANL-RADIOCHEM-1996-0004)

This event illustrated several weaknesses in work planning for the drying/ashing process. These weaknesses were that (1) the process had never been performed on this type and quantity of material, (2) there was no formalized procedure, (3) the oven vented directly into the room and could have been a problem if contamination existed, and (4) the operation was allowed to proceed unattended over the weekend. It is important that other facility organizations are aware of the operation, potential hazards, and emergency actions for unattended operations. Formal measures, such as written procedures and checklists, are particularly important for evolutions that are left unattended and therefore present a higher probability of resulting in an abnormal condition. The degree of formality should be commensurate with the risks associated with the potential hazards. A risk in this event was the potential for uncontrolled combustion of the cotton mop-head in the oven. Fibrous or cellulose materials heated at low temperatures can decompose into a combustible material. Charcloth, which is extremely flammable, is made by heating cotton while excluding most air (a process similar to making charcoal), a process very similar to the one being performed in the laboratory. The National Fire Protection Association's 18th edition of the *Fire Protection Manual* discusses another form of combustion that does not involve any flame. It is referred to as smoldering, glowing, or non-flaming combustion. A cigarette burns in this manner. Upholstered furniture containing cotton batting or polyurethane foam can also smolder. A large pile of wood chips, saw dust, or coal can smolder for weeks or even months. Smoldering is limited to porous materials that can form a carbonaceous char when heated.

KEYWORDS: fire, radiation protection, procedures

FUNCTIONAL AREAS: Industrial Safety, Work Planning, Procedures, Radiation Protection

2. CONSTRUCTION WORKER CUTS ENERGIZED 208-VOLT LINE

On August 25, 1997, at Idaho National Engineering Environmental Laboratory, a subcontractor construction worker cut an energized 208-volt line while core-drilling a cinder block wall to enlarge existing wall penetrations. He also violated the job safety analysis requirements because he did not use a drill stop and a ground-fault circuit interrupter. The construction worker was not aware that he had cut the line until a worker on the opposite side of the wall saw arcing and told him what happened. The facility manager determined that the construction manager for the primary contractor knew that the line was on the opposite side of the wall, but he did not tell the construction worker during the pre-job briefing. The facility construction manager determined that the primary contractor's construction manager properly identified the drilling location on the wall, but the construction worker drilled in another location because a handrail was in the way. Failure to communicate necessary information and to follow the job safety analysis requirements created the potential for injury and equipment damage. In addition, installing a lockout/tagout would have provided a positive barrier for worker safety. (ORPS Report ID--LITC-WASTEMNGT-1997-0021)

Investigators determined that the construction manager for the primary contractor performed a walk-down of the operation before work began and saw a conduit that contained the 208-volt line on the opposite side of the wall. He determined that the line was three-eighths of an inch from the fourth drilling location. He also decided that a lockout/tagout would not be required because the sub-contracting firm had experience with site drilling operations. Investigators determined that the construction worker who performed the drilling operation lacked this experience. They also determined that the job safety analysis required using a drill stop and a ground-fault circuit interrupter, but specific drilling equipment was not identified. However, the construction worker chose to use a hand-held core-drilling machine that did not have a drill stop or a ground-fault circuit interrupter. There was not enough clearance to enlarge the fourth penetration because a handrail obstructed the hand-held core-drilling machine, so the sub-contractor drilled one-half inch lower than originally indicated. This resulted in the 208-volt line being cut.

A construction coordinator suspended all core-drilling activities in the facility pending further investigation. In addition, he initiated a site-wide stand-down for all core-drilling and concrete saw-cutting activities until all construction personnel attend a safety meeting. Saw-cutting activities were included in the stand-down order because of a similar event that occurred at the site on August 22.

NFS has reported similar events, including the August 22 event at Idaho National Engineering Environmental Laboratory, in several Weekly Summaries.

- Weekly Summary 97-35 reported that on August 22, 1997, at Idaho National Engineering Environmental Laboratory, a construction worker cut an energized 480-volt line while saw-cutting a concrete floor. The facility manager determined that a project engineer knew that the line was under the floor but failed to recognize that it ran directly under the area where the concrete-cutting took place. The design engineer did not include a drawing showing the location of the line in the construction package given to the construction coordinator. The facility manager also determined that the construction coordinator did not complete a sub-surface survey before cutting began and that no one installed a lockout/tagout. (ORPS Report ID--LITC-SMC-1997-0005)

- Weekly Summary 97-33 reviewed four events where workers severed underground electrical and telephone lines. All of the events occurred on August 7 and 8, 1997. At Hanford, a subcontractor performing renovation activities in a building basement cut a conduit containing an energized 110-volt line. At Lawrence Livermore National Laboratory, a contractor cut an underground energized 480-volt line while using construction equipment to loosen the soil surface. At the Hanford Waste Encapsulation and Storage Facility, a back-hoe operator performing excavation activities severed an abandoned underground telephone line. When work resumed on the next day, the back-hoe operator severed an abandoned, de-energized electrical cable. (ORPS Reports RL--PHMC-WESF-1997-0007, RL--PNNL-PNNLBOPER-1997-0023, and SAN--LLNL-LLNL-1997-0051)

- Weekly Summary 96-04 reported that on January 17, 1996, at Los Alamos National Laboratory, a laborer was burned and rendered unconscious when he hit a 13.2-kV electrical power cable while excavating in a building basement. (ORPS Report ALO-LA-LANL-TSF-1996-0001 and Type A Accident Investigation Board Report on the January 17, 1996, Electrical Accident with Injury in Building 209, Technical Area 21, Los Alamos National Laboratory)

OEAF engineers reviewed the Bureau of Labor Statistics publication, *Fatal Workplace Injuries in 1995: A Collection of Data and Analysis*, and found that 6 percent of all 1995 workplace fatalities resulted from contact with electric current. An additional 2 percent of these fatalities resulted from contact with overhead power lines. Specifically, 347 deaths occurred in 1995 from electrical shocks, with 35 percent occurring to workers 25 to 34 years old and 28 percent to workers 35 to 44 years old. Only 4 percent of the workers were under 20 years old.

These events underscore the importance of using effective work control practices, effective communications, and detailed job planning to provide multiple levels of protection. Safety and health hazard analysis must be included in the work control process to help prevent worker injury. DOE-STD-1030-96, *Guide to Good Practices for Lockouts and Tagouts*, provides guidance on lockout/tagout program implementation and management at DOE facilities. Lockout/tagout programs in DOE serve two functions. The first function, defined in both 29 CFR 1910, *Occupational Safety and Health Standards*, and DOE O 5480.19, *Conduct of Operations Requirements for DOE Facilities*, is to protect personnel from injury and protect equipment from damage. The second function is to provide overall control of equipment and system status. Lockout/tagouts are typically applied during maintenance activities; however, there are many cases when lockout/tagouts are needed for personnel safety. The standard states that an effective lockout/tagout program requires three elements. These elements are as follows: (1) all affected personnel must understand the program; (2) it must be applied uniformly in every job; and (3) it must be respected by every worker and supervisor. DOE O 5480.19 states that DOE policy is to operate DOE facilities in a manner to ensure an acceptable level of safety and to ensure that procedures are in place to control conduct of operations. Chapter VIII, “Control of Equipment and System Status,” provides an overall perspective; chapter IX, “Lockout/Tagout,” and chapter X, “Independent Verification” address specific applications of system control. A good lockout/tagout program is an important element of an effective conduct of operations program. The Department of Labor estimates that compliance with the lockout/tagout standards in 29 CFR 1910.147 would prevent about 120 fatalities, 28,000 serious injuries, and 32,000 minor injuries each year. DOE facility managers should review contractor safety guidelines to ensure compliance with OSHA standards.

DOE/ID-10600, *Electrical Safety Guidelines*, prescribes DOE safety standards for the use of electrical energy at DOE field offices or facilities to enhance electrical safety awareness and mitigate electrical hazards. Section 2.13.1.6 states that lockout/tagout procedures shall be implemented to safeguard employees from injury while working on or near de-energized electric

circuits and equipment. These guidelines are intended to protect personnel from electrical shock and potential fatalities.

Facility managers should also review DOE/EH-0540, Safety Notice No. 96-05, "*Lockout/Tagout Programs*." The notice summarizes lockout/tagout events at DOE facilities, provides lessons learned and recommended practices, and identifies lockout/tagout program requirements. *The Hazard and Barrier Analysis Guide*, developed by OEAF, includes a hazard-barrier matrix that shows that lockout/tagout is the most effective barrier against injury. When implemented properly, lockout/tagout provides a high probability (greater than 99 percent) of success for risk reduction.

Safety Notice 96-05 can be obtained by contacting the ES&H Information Center, (301) 903-0449, or by writing to ES&H Information Center, U.S. Department of Energy, EH-72/Suite 100, CXXI/3, Germantown, MD 20874. Safety Notices are also available on the OEAF Home Page at http://tis.eh.doe.gov:80/web/oeaf/lessons_learned/ons/ons.html. A copy of *The Hazard and Barrier Analysis Guide* is available from Jim Snell, (301) 903-4094, and may also be obtained by contacting the ES&H Information Center, (301) 903-0449, or by writing to ES&H Information Center, U.S. Department of Energy, EH-72/Suite 100, CXXI/3, Germantown, MD 20874.

KEYWORDS: electrical safety, near miss, drilling, cable

FUNCTIONAL AREAS: Construction, Work Control, Barrier Analysis

3. INCORRECTLY DERIVED LIMITING CONDITION OF OPERATION

On August 27, 1997, at the Oak Ridge National Laboratory, an engineer conducting an annual self-assessment of the operational safety requirements for the low-level liquid waste system discovered that calculations for action statement response times to stop liquid transfers were incorrectly derived. The calculations provide the required response time to prevent collection tank overflow when the limiting condition of operation level is exceeded. Engineers derived the calculations in the safety documentation using gallons, based on tank volume, but the level instrument at the tank indicated level based on liquid height. The difference between gallons based on height and gallons based on volume resulted in a smaller free volume in the tank and required a shorter response time to stop the pumping operation. Previous reviews of the safety documentation failed to identify this discrepancy. Tank overflows could result in the spread of contamination and release of hazardous materials to the environment. (ORPS Report ORO--LMES-X10WSTEMRA-1997-0003)

The safety document stated: “local tank level indication shall be used to assure tanks do not overflow.” It also stated that a local level reading of 95 percent for a 50,000-gallon tank equated to a volume of 47,500 gallons and provided a free volume of 2,500 gallons. Engineers derived the response time, or the action taken upon exceeding the 95 percent limiting condition of operation level, by dividing the free space gallons by the fill rate of 80 gpm. They assumed that the 95 percent reading corresponded to a liquid level of 47,500 gallons (direct correlation between percent read-out and tank volume). During the self-assessment, the engineer discovered that the local instrumentation indicates the span of the tank in liquid height, not liquid volume. Therefore, a local reading of 95 percent was actually 48,987 gallons instead of 47,500 gallons. The response needed to prevent overflow, upon exceeding the limiting condition of operation, would therefore be less than that given in the action statement.

Investigators determined that the incorrectly derived limiting condition of operation has existed for years. Successive annual reviews and revisions to the safety documentation did not identify

this problem. The reviewing engineer discovered the problem when a computer technician mentioned that there were differences in instrument calibrations. System Safety Engineering personnel confirmed the violation and are reviewing changes to the operating procedures and safety documentation. They immediately notified operating personnel of the issues through the site required reading files. Facility personnel are considering several corrective actions, including installing a computer chip in the instrumentation to change the readings; rewriting the safety documentation; or limiting the tank fill to 93 percent.

NFS reported an event in Weekly Summary 95-08 where an inadequate technical review resulted in a tank overflow. Operators at the Savannah River Defense Waste Processing Facility overflowed the contents of a tank into a ventilation system. Engineers told the operators that they could fill the tank above a vent-line penetration. When the operators pressurized the tank, 800 gallons of chemicals flowed out the tank vent. The engineer's review did not consider that fluid would flow out of the vent line if the tank were pressurized and filled above the vent-line penetration. (ORPS Report SR--WSRC-WVIT-1995-0014)

This event underscores the importance of performing comprehensive periodic self-assessments of facility safety documentation. This event also illustrates that discrepancies can go undetected after many reviews and revisions. Ideally, the initial technical and design reviews should identify and resolve any safety issues before being incorporated in the facility safety documentation. It may be necessary for self-assessments to include cross-disciplinary reviews by supporting organizations to ensure that all elements of design, function, and operation are evaluated. DOE O 5480.22, *Technical Safety Requirements*, provides guidance for performing reviews and audits of safety documentation.

KEYWORDS: limiting conditions for operations, instrumentation, tank, level, operational safety requirement

FUNCTIONAL AREAS: Licensing/Compliance

4. FIVE WORKERS EXPOSED TO NITROGEN OXIDES

On August 25, 1997, at Idaho National Engineering Environmental Laboratory, five workers were exposed to nitrogen oxides while conducting a remote video inspection to determine the source of water intrusion into a below-ground valve box. The workers smelled the nitrogen oxides after opening the valve box. They attempted to continue their work, but the odor became stronger; so they stopped work, shut the valve box, and reported to the facility dispensary. Medical personnel observed the workers for 72 hours and detected no symptoms of over-exposure. An industrial hygienist performed follow-up surveys and determined that the exposures exceeded the National Institute for Occupational Safety and Health's, *Pocket Guide to Chemical Hazards*, ceiling limit (5 parts per million). However, the best estimate, based on the industrial hygienist's survey results, was that the "immediately dangerous to life and health level" from the guide (20 parts per million) was not reached. Nitrogen oxides exposure can cause coughs, chest pains, respiratory problems, and eye irritations. (ORPS Report ID--LITC-WASTEMNGT-1997-0020)

The valve box, located outdoors, contains valves and thermally heated process off-gas lines from the calcining facilities. Investigators determined that an engineer prepared the work package allowing the workers to remotely inspect the valve box. They also determined that, when preparing the work package, the engineer used measurements for nitrogen oxides taken by industrial hygienists approximately 3 weeks earlier. These measurements showed negligible levels of nitrogen oxides outside of the valve box and up to 12 parts per million midway into the box. Because the valve box is located outside, changing weather conditions can affect the measured levels. However, investigators determined that the engineer did not specify additional requirements for monitoring (pre-job or during the job) levels of nitrogen oxides in the work package. They also determined that the work package did not specify using personnel protective

equipment for nitrogen oxides or a safe work permit. However, investigators determined a shift supervisor had installed a caution tag on the valve box several weeks earlier indicating the presence of potentially high levels of nitrogen oxides and requiring a safe work permit to open the box.

The facility representative believes that, because the off-gas line was heated, the nitrogen oxides also were heated, and they rose to the surface when the workers opened the valve box. Investigators compared the levels of nitrogen oxides measured in the follow-up surveys after the event with the surveys taken before the work package was prepared and determined that the levels did increase. They also determined that no one reviewed the work package before starting the job to determine if the conditions and assumptions remained valid. Facility managers are continuing to evaluate this event to determine corrective actions and the cause of increasing levels of nitrogen oxides. Corrective actions will be implemented when the investigation is completed.

NFS has reported similar events where the work control process failed to adequately address worker safety in several Weekly Summaries.

- Weekly Summary 97-08 reported that on February 12, 1997, at the Los Alamos National Laboratory, an occurrence investigator reported that sub-contractor personnel violated work control procedures. This resulted in bypassing the normal environment, safety, and health review for a job package. The sub-contractor used a priority 1 work ticket to perform tests on a fire alarm panel. The facility manager subsequently determined that the task was not emergency work and the priority 1 status was incorrectly used, which could have exposed workers to potential electrical hazards. (ORPS Report ALO-LA-LANL-TSF-1997-0001)

- Weekly Summaries 93-50 and 94-01 reported that on December 12, 1993, at the Idaho Chemical Processing Plant Tank Farm, two construction workers received whole body radiation doses of 770 mrem and 507 mrem, and skin doses of 4,469 mrem and 2,040 mrem while completing work in a valve box. Investigators determined that inadequate administrative control, violating procedural requirements, inadequate procedures, and work organization/planning deficiencies were among causes that contributed to the event. (ORPS Report ID-WINC-WASTEMNGT-1993-0014)

OEAF recommends performing hazard assessments for all jobs. Hazard assessments are valuable for identifying inherent or potential hazards that may be encountered in the work environment. At a minimum, a hazard assessment should include four elements.

- Identifying the operation or job to be assessed.
- Dividing the job or operation into constituent tasks.
- Identifying the hazards associated with each task.
- Determining the necessary hazard controls.

Successful evaluation and identification of hazards must be an on-going process and should be performed for the following job phases.

- initially, during the work planning phase
- immediately when the work process or job starts (This assessment should be a more detailed, “real time” evaluation and should be used to further define existing hazards and to aid in the selection of appropriate engineering and administrative controls.)
- before any change in the job, task, or process

- as required by changing work conditions
- continually, as appropriate

Managers and supervisors in charge of job performance should conduct routine inspections of their work sites to identify new or previously overlooked hazards and failures to control known hazards.

These events underscore the importance of using effective work control and job planning practices and performing complete evaluations of potential hazards. Safety and health hazard analysis must be included in the work control process to help prevent injuries and exposures to changing environmental conditions and chemicals. Safety and health hazard analysis should include information such as permissible exposure limits; thermal data; currents material safety data sheets. Physical data, such as boiling points; freezing points; and flash points should be included in the work control process to help prevent injuries and exposures to hazardous environments or chemicals. Work package preparers and reviewers should ensure environmental hazards are evaluated for changing conditions, including temperature, pressure, wind, and rain. Facility managers should review procedures for preparing work packages to ensure that the reviews are performed correctly and changing environmental conditions are identified. DOE 0 440.1, *Worker Protection Management for DOE Federal and Contractor Employees*, states that the contractor must identify workplace hazards and evaluate the risk of associated worker injury or illness. DOE 4330.4B, *Maintenance Management Program*, section 8.3.1, provides guidelines on work control systems and procedures. The Order requires using control procedures to help personnel understand the requirements for working safely.

DOE-STD-1050-93, *Guideline to Good Practices for Planning, Scheduling and Coordination of Maintenance at DOE Nuclear Facilities*, section 3.1.1.3, provides the key elements of an effective planning program. Included is guidance on consistency in planning between disciplines to avoid confusion and frustration of work groups. The standard also discusses the need for thorough reviews of work packages by experienced individuals to eliminate errors. Managers at DOE facilities should review their planning programs and policies to ensure consistency with the guidance in the standard.

KEYWORDS: exposure, nitrogen oxide, work control

FUNCTIONAL AREAS: Hazards Analysis, Work Planning, Industrial Safety